

## Comparison the effect of DG oil with Spirotetramat and Dinotefuran on common pistachio psylla, *Agonoscena pistaciae* Burckhardt & Lauterer (Hem.: Aphalaridae) in different cities of Iran

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### Abstract

The common pistachio psyllid, *Agonoscena pistaciae* is a key pest of pistachio trees in Iran. Both adults and nymphs cause great economic damages by sucking sap and produce large amounts of honeydew. The continued use of pesticides to control *A. pistaciae* leads to resistant of its populations to several pesticides and inefficiencies in biological control, resulting in pest outbreaks. In the present study, Field experiments were conducted during 2019–2020 on pistachio trees, the Ahmad Aghaei cultivar, in Kerman, Yazd, Qom, Khorasan Razavi, Khorasan Shomali, Khorasan Jonoubi, Semnan, Fars, Markazi, and Esfahan provinces to evaluate the effect of DG oil on *A. pistaciae* in comparison with the two pesticides Spirotetramat and Dinotefuran. The sampling was carried out a day before spraying and 1, 3, 7, 14, 21 and 28 days post-treatment. The experiments were conducted based on complete randomized blocks with four treatments (included the recommended dosage of DG oil (0.5 liter/1000 liter water/ha), Spirotetramat (1 liter/1000 liter water/ha), Dinotefuran (0.75 kg/ 1000 liter water/ha and control (Spraying with water) and four replications. Results showed a high performance of DG oil starting from the first day after spraying and Continued for four weeks. Compared to Spirotetramat and Dinotofuran, DG oil had a suitable and satisfied performance. DG oil is recommended as the most environment-friendly and IPM compatible compound to control *A. pistaciae*.

**Keywords:** Common pistachio psyllid, DG oil, Spirotetramat, Dinotefuran

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Received: 10 June.2022 – Accepted: 27 Aug.2022



## Introduction

Pistachio (*Pistacia vera* L.), as one of the most important horticultural products is of significant economic importance especially in terms of export (Alizadeh *et al.* 2007; Amirghasemi and Sozani, 2009; Hassani *et al.*, 2009). Many pests and diseases damage pistachio trees (Porkhosravani *et al.*, 2020), so due to its economic importance of pistachio, a significant number of studies have been conducted to investigate control methods on pistachio pests and diseases in Iran. The indigenous common pistachio psylla (CPP), *Agonoscena pistaciae* Burckhardt and Lauterer (Hem.: Aphalaridae), to Iran, also called dry sap, is one of the most significant pests in nearly all pistachio growing regions of Iran. The pest causes tremendous pistachio yield loss every year (Samea *et al.*, 2005; Hassani *et al.*, 2009; Mehrnejad, 2002). Both nymphs and adults suck up the sap of leaves resulting in defoliation, stunting, poor yield and bud drop (Samea *et al.* 2005; Mehrnejad, 2010; Mehrnejad, 2014). The pest produces large amounts of honeydew which absorb dust and microorganisms, thus preventing photosynthesis (Porkhosravi *et al.*, 2020; Sheibani & Hassani, 2014).

Various pesticides from different groups are widely used to control pistachio psylla annually as the main control measure of the pest management programs. The pistachio trees are in some years and some areas sprayed more than 18 times (Lababidi 2002; Panahi *et al.*, 2013; Razavi and Mahdian, 2015; Roshani *et al.*, 2020).

Multi-generation (multivoltine) and high reproduction rate of *A. pistaciae* and the prolonged use of chemical insecticides for several years has made the pest resistant to many insecticides (Basirat *et al.*, 2007; Mehrnejad, 2002; Hassani *et al.*, 2009., Roshani *et al.*, 2020). In addition, some of insecticides used have adverse effects on natural enemies of CPP, especially parasitic wasps (Mehrnejad, 2002). Thus, regarding to the pest resistance, pest outbreaks, and annual spraying, it is believed that its chemical control needs to be reconsidered. The importance of pistachio export, shows the importance of finding of the safest, most environmentally-friendly and IPM compatible compounds to control *A. pistaciae* such as using Adjuvants

Adjuvants are often added to insecticides to facilitate the wetting and the spread of droplets on leaves, resulting in a more uniform distribution of active ingredients (Foy, 1989; Pollicello *et al.*, 1995). Most adjuvants have shown insecticidal activity (Srinivasan *et al.*, 2008). Among the adjuvants, DG oil is a new anionic surfactant, together with polarized solvents, which causes surface tension and thus increases the absorption of pesticides by the plant DG oil has also shown insecticidal activity to several pests including aphids and coccids. Our preliminary tests showed that DG oil is effective in suppressing the population of *A. pistaciae*, which might be suitable for its IPM programs and producing organic products.

Spirotetramat SC 10% and Dinotefuran SG 20% are two mainly insecticides prevalently used against *A. pistaciae* in most pistachio growing regions of Iran (Ranjbar-shoorabadi, *et al.*, 2020; Roshani *et al.*, 2020). Spirotetramat is a systemic insecticide belonging to the tetramic acid group and acts in inhibiting the biosynthesis of lipids in insects (Cantoni *et al.*, 2008; Nauen *et al.*, 2008). Spirotetramat spreads through almost all plant tissues, including vascular tissues (phloem and wood), roots, leaves and stems to control a wide range of sucking pests (Cantoni *et al.*, 2008; Nauen *et al.*, 2008). The other pesticide Dinotefuran is a contact and oral neonicotinoid insecticide, which disrupts the transmission of neural messages by affecting the neonicotinoid receptors of acetylcholine (Corbel *et al.*, 2004). The aim of this study was to evaluate the effectiveness of DG oil, as an environmentally- friendly pesticide, in comparison with Dinotefuran and Spirotetramat, as two widely used chemicals in pistachio orchards, under field conditions in different regions of Iran.

## Materials & methods

The present study assessed the efficacy of DG oil adjuvant (Gyah corporation, Iran), Spirotetramat (Bayer, Germany), and Dinotefuran (Mitsui chemicals, Japan) against *A. pistaciae* on Pistachio trees under field conditions in 10 different cities.

This study was carried out in pistachio orchards used the Ahmad Aghaei cultivar in Kerman, Yazd, Qom, Khorasan Razavi, Khorasan Shomali, Khorasan Jonoubi, Semnan, Fars, Markazi, and Esfahan provinces. The trees were approximately 15 years old. In this study, pistachio orchards in terms of vegetation and height were similar. Spraying was done in clear and completely sunny weather and at an ambient temperature between 25 °C and 28 °C.

The experiments were conducted based on complete randomized blocks with four (numbers less than ten should be written in words) treatments and four replications. Treatments included the recommended dosage of DG oil (0.5 liter per 1000 liter water/ha), Spirotetramat (1 liter per 1000 liter water/ha), Dinotefuran (0.75 kg per 1000 liter water/ha and control (Spraying with water). . The sampling was carried out a day before test and 1, 3, 7, 14, 21 and 28 days post-treatment. For sampling of each treatment, four trees in the center rows were randomly selected and from each one, five leaves were picked (twenty leaves for each treatment). The leaves were picked randomly in different directions and also in the top and bottom of each tree. The nymphs and adults of common pistachio psyllid on upper and lower sides of each leaf were counted and recorded. The percentage population change of each treatment at each locality in sampling dates was figured with the Henderson-Tilton formula (1955) as follows:

$$\text{Population reduction \%} = [1 - (X_{IT} / X_{ic}) (X_{0c} / X_{0T})] \times 100$$

Where the  $X_{0c}$  and  $X_{0T}$  are the average numbers of live psyllids in the control plot and pre-spraying treatment, respectively.  $X_{ia}$  and  $X_{iT}$  are the average numbers of live psyllids in the control plot and post-spraying treatment, respectively.

### Statistical analysis

Statistical analysis of the mean percentage of population reduction was performed using SPSS 26 software ([version?](#)) through one-way analysis of variance (ANOVA) and the mean comparisons was made by Tukey's test ( $P < 0.05$ ).

### Results & Discussion

Due to the high consumption of chemical pesticides and its side effects, using safe compounds in agriculture has found a special place today to ensure public health; (Alizadeh *et al.*, 2011).

Therefore, introduction of new safe compounds is required to be used in control of agriculture pests, such as common pistachio psylla. The results of the present study showed that there is a significant difference among treatments at 1, 3, 7, 14, 21, and 28 days post-treatment (Table 1). The comparison of mean percentage of efficacy of tested insecticides showed a significant difference between DG oil treatment with Spirotramat and Dinotofuran immediately after spraying up to 7 days post-treatment. The highest mortality was obtained with DG oil, in all localities at 1, 3, and 7 days post-treatment (Fig. 1, Fig. 2, Fig. 3). After consuming DG oil, the pest population was drastically reduced and the economic injury level decreased. Sampling on the seventh day showed that the DG oil treatment with the highest mortality had a significant difference with the two other treatments, Spirotramat and Dinotofuran. However, the mortality rate in Spirotramat and Dinotofuran treatments increased after 7 days post treatment which can be explained by systemic characteristic of the two pesticides.

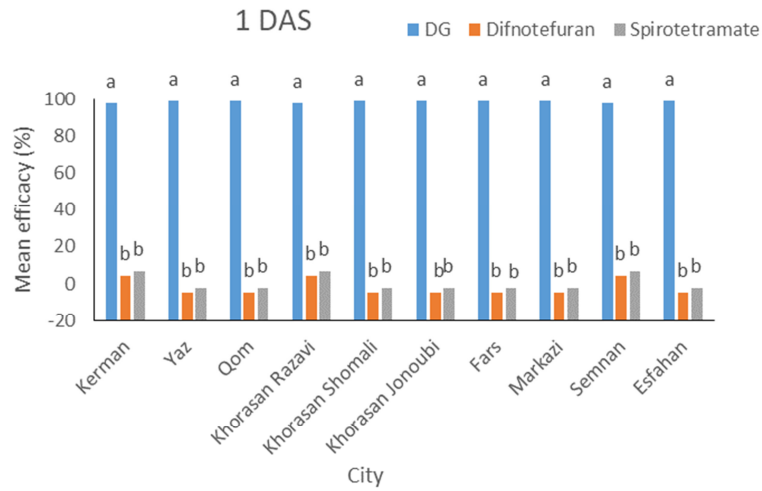


Fig. 1. The mean±SE efficacy of DG oil, Spirotetramat, and Dinotefuran on *Agonosцена pistaciae* in different cities of Iran one day after application. (The means with the same letter are not significant different at > 0.05 by tukey<sup>s</sup> test, SPSS 26.)

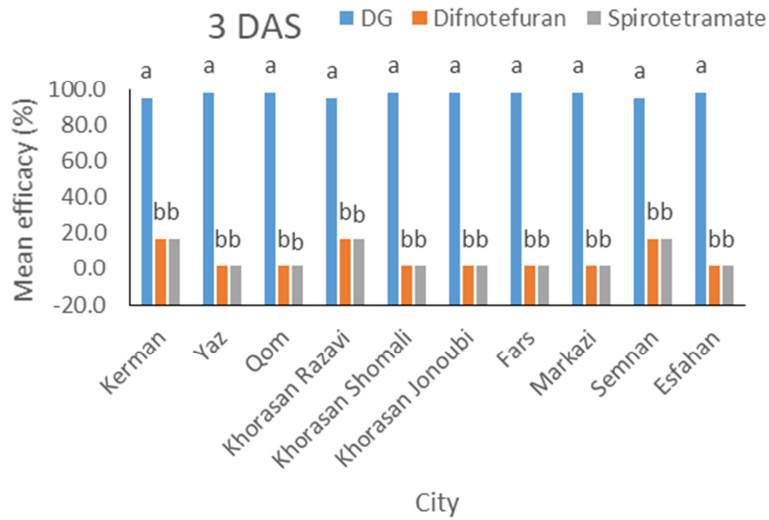


Fig. 2. The mean±SE efficacy of DG oil, Spirotetramat, and Dinotefuran on *Agonosцена pistaciae* in different cities of Iran three days after application. The means with the same letter are not significant different at > 0.05 by tukey<sup>s</sup> test, SPSS 26.

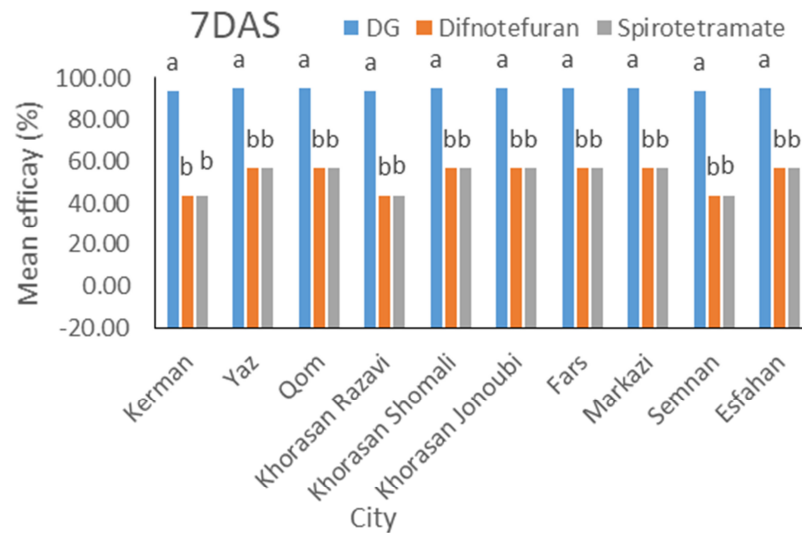


Fig. 3. The mean±SE efficacy of DG oil, Spirotetramate, and Dinotefuran on *Agonoscena pistaciae* in different cities of Iran seven days after application. The means with the same letter are not significant different at > 0.05 by tukey<sup>s</sup> test, SPSS 26.

Sampling on the 14th day showed that DG oil with the highest mortality in Kerman, Khorasan Razavi, and Semnan, is still significantly different from Dinotefuran and Spirotetramat. While, in other localities including Qom, Yazd, Khorasan shomali, Khorasan jonoubi, Fars, Markazi, and Esfahan provinces the mean mortality of Spirotetramat and Dinotefuran showed no significant difference with DG oil and even, Spirotetramat showed the highest mortality rate which can be related to its higher systemic characteristic (Fig. 4).

Sampling on the 21st day showed that in all sprayed areas, the mean mortality rate of DG oil showed significant reduction in comparison with Spirotetramate and Dinotefuran (Fig. 5). However, DG oil still had a good level of control (> 90% mortality rate) and the pest did not reach the level of economic losses. Thus, there was no need for re-spraying, and farmers were satisfied with the control of DG oil.

Twenty-eighth-day sampling showed that the control rate is above 80% in all treatments (Fig.6). In the study of Gheibi and Taheri (2017) the efficacy of Spirotetramate increased after 7 days post- treatment, so that the highest mortality (98.23%) was obtained 30 days after spraying.

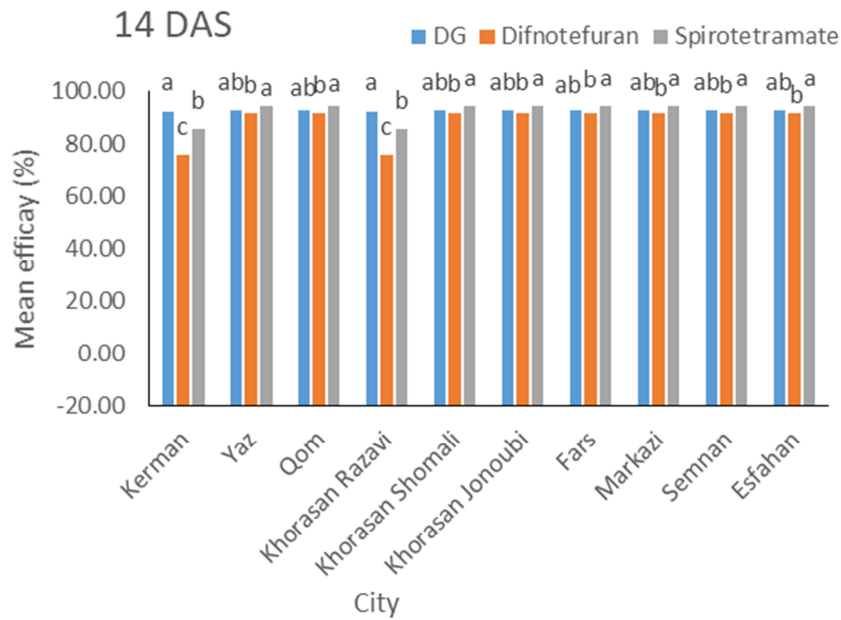


Fig. 4. The mean±SE efficacy of DG oil, Spirotetramate, and Dinotefuran on *Agonosцена pistaciae* in different cities of Iran at 14 days after application. The means with the same letter are not significant different at > 0.05 by tukey<sup>s</sup> test, SPSS 26

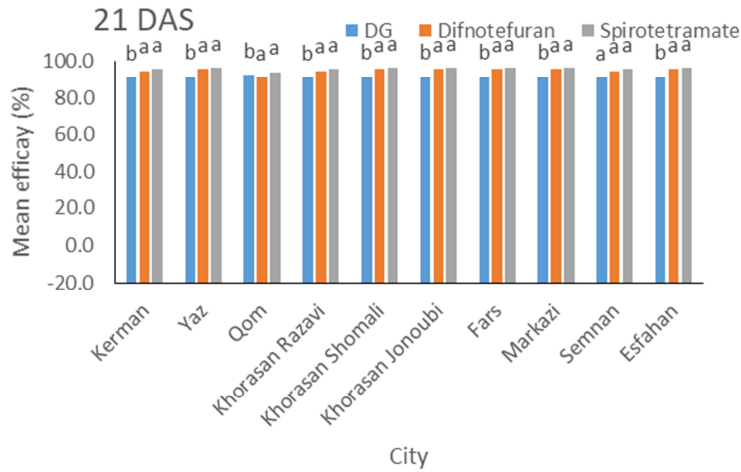


Fig. 5. The mean±SE efficacy of DG oil, Spirotetramate, and Dinotefuran on *Agonosцена pistaciae* in different cities of Iran at 21 days after application. The means with the same letter are not significant different at > 0.05 by tukey<sup>s</sup> test, SPSS 26.

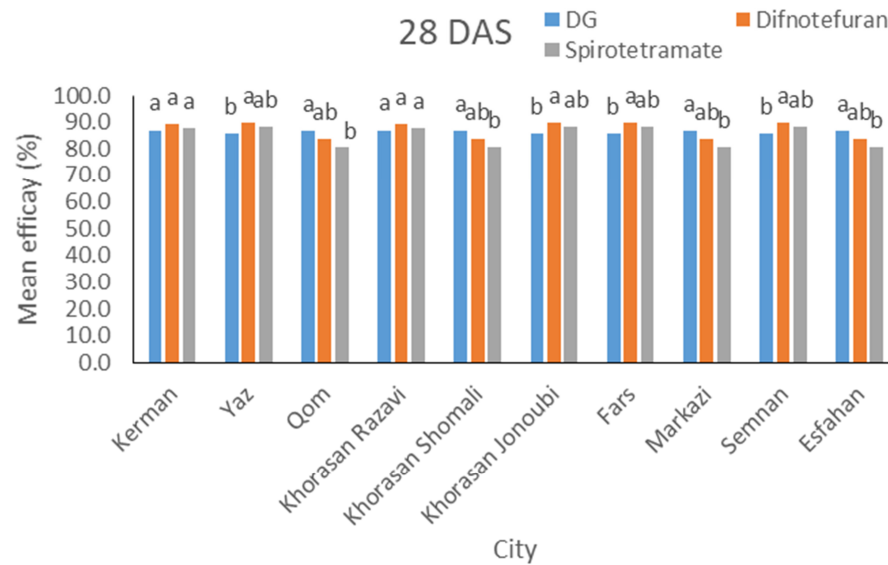


Fig. 6. The mean $\pm$ SE efficacy of DG oil, Spirotetramate, and Dinotefuran on *Agonoscena pistaciae* in different cities of Iran at 28 days after application. The means with the same letter are not significant different at  $> 0.05$  by tukey's test, SPSS 26.

The results showed that DG oil, according to the conditions and time of use, at first days of spray has a much more effect than Spirotetramate and Dinotefuran. It is recommended that chemical control of *A. pistaciae* should be done in the early stages to make DG oil more suitable for use. However, High efficacy of DG oil at 28th days post-treatment, showed its durability in controlling this pest. Results showed that the high performance of DG oil starts from the first day after spraying and lasts till 4 weeks. Compared to Spirotetramate and Dinotefuran, DG oil has a suitable and satisfactory performance.

This study showed that in different tested regions of the country, in trees with the same cultivar, age, and canopy, different results for efficacy of tested insecticide were observed.

In conclusion, DG oil showed high efficacy in controlling common *Psylla pistachio* in most regions. Considering the early effect of DG oil as well as long lasting effect, and being less harmful for the environment, people and also for non-target organisms, this compound can be introduced as a new pesticide for effective control of *A. pistaciae* in IPM.

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Table 1. Comparison of mean efficacy (%) among DG oil, Spirotetramat, and Dinotefuran insecticides on *Agonoscena pisatciae*

Days after application	Mean efficacy (%)									
	Province									
	Kerman	Yazd	Qom	Razavi Khorasan	North Khorasan	South Khorasan	Semnan	Markazi	Fars	Esfahan
1	P<0.0001	P<0.0001	P<0.0001	P<0.0001	P<0.0001	P<0.0001	P<0.0001	P<0.0001	P<0.0001	P<0.0001
	F= 107.63	F=120.67	F=120.67	F= 107.63	F=120.67	F=120.67	F=120.67	F=120.67	F= 107.63	F=120.67
	df= 2,33	df= 2,33	df= 2,33	df= 2,33	df= 2,33	df= 2,33	df= 2,33	df= 2,33	df= 2,33	df= 2,33
3	P<0.0001	P<0.0001	P<0.0001	P<0.0001	P<0.0001	P<0.0001	P<0.0001	P<0.0001	P<0.0001	P<0.0001
	F=126.271	F=155.56	F=155.56	F=126.271	F=155.56	F=155.56	F=155.56	F=155.56	F=126.271	F=155.56
	df= 2,33	df= 2,33	df= 2,33	df= 2,33	df= 2,33	df= 2,33	df= 2,33	df= 2,33	df= 2,33	df= 2,33
7	P<0.0001	P<0.0001	P<0.0001	P<0.0001	P<0.0001	P<0.0001	P<0.0001	P<0.0001	P<0.0001	P<0.0001
	F=276.533	F=803.28	F=803.28	F=276.53	F=803.28	F=803.28	F=803.28	F=803.28	F=276.53	F=803.28
	df= 2,33	df= 2,33	df= 2,33	df= 2,33	df= 2,33	df= 2,33	df= 2,33	df= 2,33	df= 2,33	df= 2,33
14	P= 0.006	F=0.025	P=0.025	P= 0.006	P=0.025	F=0.025	F=0.025	F=0.025	P= 0.006	F=0.025
	F=17.55	F=4.145	F=4.145	F=17.55	F=4.145	F=4.145	F=4.145	F=4.145	F=17.55	F=4.145
	df= 2,33	df= 2,33	df= 2,33	df= 2,33	df= 2,33	df= 2,33	df= 2,33	df= 2,33	df= 2,33	df= 2,33
21	P= 0.006	P<0.0001	P<0.0001	P= 0.006	P<0.0001	P<0.0001	P<0.0001	P<0.0001	P= 0.006	P<0.0001
	F=5.953	F=14.736	F=14.736	F=5.953	F=14.736	F=14.736	F=14.736	F=14.736	F=5.953	F=14.736
	df= 2,33	df= 2,33	df= 2,33	df= 2,33	df= 2,33	df= 2,33	df= 2,33	df= 2,33	df= 2,33	df= 2,33
28	P= 0.28	P=0.005	P=0.007	P= 0.28	P=0.007	P=0.005	P=0.005	P=0.005	P= 0.28	P=0.005
	F=1.325	F=6.336	F=5.768	F=1.325	F=5.768	F=6.336	F=6.336	F=6.336	F=1.325	F=6.336
	df= 2,33	df= 2,33	df= 2,33	df= 2,33	df= 2,33	df= 2,33	df= 2,33	df= 2,33	df= 2,33	df= 2,33

## مقایسه اثر روغن DG با اسپیروتترامات و دینوتفوران بر پسیل معمولی

پسته، *Agonoscena pistaciae* Burckhardt & Lauterer (Hem.:

Aphalaridae) در شهرهای مختلف ایران

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## چکیده

پسیل معمولی پسته، *Agonoscena pistaciae* از آفات کلیدی درختان پسته در ایران است. هم‌حشرات بالغ و هم‌پوره‌ها با مکیدن شیره گیاه، خسارات اقتصادی زیادی وارد کرده و همچنین مقدار زیادی عسلک تولید می‌کنند. استفاده مداوم از آفت‌کش‌ها برای کنترل *A. pistaciae* منجر به مقاومت شدن جمعیت‌های آفت به چندین آفت‌کش و ناکارآمدی در کنترل بیولوژیکی و در نتیجه سبب طغیان آفات می‌شود. در تحقیق حاضر، آزمایش‌های مزرعه‌ای طی سال‌های ۱۳۹۸-۱۳۹۹ بر روی درختان پسته رقم احمد آقایی در استان‌های کرمان، یزد، قم، خراسان رضوی، خراسان شمالی، خراسان جنوبی، سمنان، فارس، مرکزی و اصفهان انجام شد. بررسی تاثیر روغن DG بر *A. pistaciae* در مقایسه با دو آفت‌کش Spirotetramat و Dinotefuran با نمونه برداری از تیمارها یک روز قبل از سمپاشی و ۱، ۳، ۷، ۱۴، ۲۱ و ۲۸ روز پس از تیمار انجام شد. آزمایش‌ها بر اساس بلوک‌های کامل تصادفی با چهار تیمار (شامل دوز توصیه شده روغن DG ۰/۵ لیتر در ۱۰۰۰ لیتر آب در هکتار)، اسپیروتترامات (۱ لیتر در ۱۰۰۰ لیتر آب در هکتار)، دینوتفوران (۰/۷۵ کیلوگرم در ۱۰۰۰ لیتر آب در هکتار) و شاهد (محلول‌پاشی با آب) و در چهار تکرار انجام شد. نتایج نشان داد که روغن DG از روز اول پس از سمپاشی کارایی بالایی داشت و تاثیرگذاری آن به مدت چهار هفته ادامه یافت و روغن DG در مقایسه با اسپیروتترامات و دینوتفوران عملکرد مناسب و رضایت بخشی داشت. به عنوان دوستدار محیط زیست و سازگارترین ترکیب با IPM برای کنترل *A. pistaciae* توصیه می‌شود.

واژه‌های کلیدی: پسیل معمولی پسته، روغن DG، اسپیروتترامات، دینوتفوران

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تاریخ دریافت مقاله: ۱۴۰۱/۳/۲۰ - تاریخ پذیرش مقاله: ۱۴۰۱/۶/۰۵

